

### **REMARKS**

The claims have been amended. In particular, the independent claims are amended to clarify that the reduction step is carried out by immersing in an aqueous solution containing a reducing agent. Support for this amendment can be found throughout the original specification where the processing of the metal electrode is described, for example at page 19, lines 3-6. Additionally, new claims 13-23 have been added. Support for each of these claims is found in the original specification, for example at pages 17-20. New claims 20-23 relate to exchanging the counter ions with alkylammonium ions, and support for this subject matter can be found in the original specification at page 8, line 7 through page 10, line 9.

In the non-final Office Action dated June 3, 2003, claims 1 and 8-12 have been rejected under 35 U.S.C. §103(a) as unpatentable over WO 97/26039 to Shahinpoor et al. either considered alone or together with US 4,364,803 to Nidola et al. This rejection is respectfully traversed.

The present invention is directed to a process for producing a polymeric actuator in which the (i) adsorption step, (ii) deposition step, and (iii) washing step are repeatedly conducted to form the metal electrodes, in which metal deposition is conducted inside of the ion-exchange resin, and in which the formation of a metal complex is conducted by immersing the ion-exchange resin product adsorbing the metal complex thereon in an aqueous solution. In the present invention, reduction of a metal complex is accomplished by a step of immersing the ion-exchange resin into an aqueous solution of a reducing agent, that is, by step (ii). A metal electrode of the polymeric actuator of the present invention is not formed until the deposition step (ii) is conducted. Since a metal complex is not reduced by the adsorption step (i) or the washing step (iii) in the process of the present invention, there is no reduction to generate a metal complex other than during the deposition step (ii). In other words, in the process of the present invention, coating of the ion-exchange resin product with a reduced metal is only carried out in the step of (ii) deposition.

Further, since the process involves an ion-exchange resin product adsorbing a metal complex without generating a metal in step (i), followed by the deposition step of (ii) deposition, further followed by a washing step of (iii), the process in accordance with this specific order, and more particularly repeatedly conducting the steps in this specific order,

enables metal deposition not only on a surface of a resin product but also inside thereof. Thus, since in the polymeric actuator of the present invention, a reduction of a metal complex which forms a metal electrode is conducted by immersion of the ion-exchange resin, in a reducing agent after a separate and distinct step of adsorbing the metal complex, metal deposition occurs not only on the surface of a resin product but also inside thereof. Therefore, the separate deposition step of (ii) plays an important role. In case the deposition step of (ii) is missing or in case the order of repetition is changed, it is impossible to deposit a satisfactory amount of metal inside of the resin product surface.

On the other hand, WO 97/26039 discloses in page 3, line 24 to page 4, line 3 thereof, a process for producing actuators by conducting specific steps in a specified order, namely, in which the steps are rinsing an ion-exchange resin, coating the ion-exchange product by a chemically reduced agent (coating step), followed by a reducing step by exposing said coating to a reduced agent. The process for producing an actuator in WO 97/26039 is a process which requires coating of an ion-exchange product by a reduced agent before the step of reduction of exposing said coating to a reduced agent. In addition, in page 4, lines 18 to 21 of WO 97/26039, this reference discloses that said coating is conducted by coating the ion-exchange material with a coating of about  $3.75 \text{ mg/cm}^2$  of the coating substance. In the same portion, WO 97/26039 also discloses that it is preferable that said coating is conducted using metals, in particular, noble metals. Further, page 11, lines 14 to 17 of WO 97/26039 discloses that the process for producing said actuators includes rinsing membranes, coating membranes with a chemically reduced substance in the presence of a reducing agent, and reducing the membrane coating by exposing the membranes to a reduced agent.

In the invention of the present application, the process conducted before the process of reducing a metal complex by a reduced agent is an adsorption step (i) in which a metal complex is adsorbed by an ion-exchange resin in the aqueous solution, not a step of coating. For example, merely immersing into an aqueous solution, such as only tetra-amine platinum salt, does not cause metal to deposit. Clearly, metal coating is impossible in the adsorption step of the present invention. In order to cause deposition of the metal from tetra-amine platinum salt, an oxidation-reduction reaction is necessary, and in order to generate metal deposition, the presence of a reducing agent is necessary (except for the method of

electrolysis). That is, by the adsorption step (i) in the present application, it is impossible to form a metal coating on a surface of an ion-exchange resin product. Therefore, the adsorption step (i) of the process of the present invention differs from the coating step in the process for producing actuators as disclosed by WO 97/26039.

Further, WO 97/26039 also discloses in page 11 lines 19 to 27 a method comprising a first cleaning step, at least one step (preferably two steps) of rinsing a membrane, at least one step of coating the membrane with the substance which undergoes chemical reduction in the presence of a reducing agent, at least one step (preferably two steps) of reducing the coating on the membrane by exposing the membrane to a reducing agent, a second cleaning step, and at least one (preferably two steps) of storing the treated membrane. However, in this portion of WO 97/26039, there is no clear disclosure that each step is conducted one by one in a certain order.

In fact, at page 12, line 6 to page 14 line, 15 of the publication of WO 97/26039, a specific embodiment of the disclosed manufacturing method is described. In this specified embodiment, it is noted at page 14, line 10, that "steps 7, 8 and 9 are repeated". In step 7, both a metal complex and a reducing agent are used. In this step, the membrane is rinsed prior to immersing in an aqueous solution including both a metal complex and hydrazine monohydrate, which is a reducing agent. Next, said membrane is exposed to a further reducing agent by adding hydrazine monohydrate, which is a reducing agent, gradually. In this procedure where a membrane is immersed into an aqueous solution including both a metal complex and hydrazine monohydrate reducing agent, it is a matter of course that a metal is deposited on a membrane since a metal complex included in the solution is reduced by a reducing agent included in the same solution. The coating process of WO 97/26039 is a process of immersing a membrane in an aqueous solution including both a metal complex and the hydrazine monohydrate as the reducing agent. That is, to be specific, any repeated coating process of WO 97/26039 involves a step of coating of ion-exchange resin product with a chemically reduced substance conducted by immersing a membrane into an aqueous solution containing both a metal complex and a reducing agent. When this coating process is accomplished, since reduction of a metal complex begins before a metal complex penetrates into the inside of the ion-exchange resin product, it is difficult to generate a metal-deposition

such as in the present invention, which provides for metal deposition in the inside of the ion-exchange resin product.

Therefore, since this coating step is clearly different from the adsorption process of the present invention, WO 97/26039 does not render the present invention obvious. In fact, the Examiner specifically recognizes that Shahinpoor WO 97/26039 fails to disclose that the step of adsorbing metal complexes can be repeated. WO 97/26039 not only fail to disclose the adsorbing step, but it fails in any way to suggest that metal can be deposited within the membrane structure through repeatedly conducting the adsorption, deposition and washing steps separately.

The Examiner further rejects the present invention contending that it is obvious from the combination of WO 97/26039 and US 4,364,803. However, the production method disclosed in US 4,364,803 to Nidola is a production method in which a membrane surface is subject to a pre-treatment with an amphoteric material before coating as stated at column 1, lines 61 to 68. Column 2, lines 7 to 9 of US 4,364,803 also states that uniform coating of an electrodic surface is obtained with a noble metal. As stated in column 4, lines 60 to 64 of US 4,364,803, by making an amphoteric material adsorb to a membrane, a selected metal salt is adsorbed and/or absorbed in membrane active sites. Column 4, lines 65 to 68 of US 4,364,803 further states that adsorption of a metal salt takes place on the membrane surface. In other words, US 4,364,803 states that a metal coat is obtained on a membrane surface since a metal salt is adsorbed on a membrane surface by making an amphoteric material adsorb to a membrane. US 4,364,803 does not state that the metal deposition is obtained inside of the ion-exchange resin product.

The present invention, on the other hand, has no pre-treatment with an amphoteric material. In the adsorption process of the present invention, a metal salt is not selectively adsorbed in membrane active sites and therefore, a metal complex is liable to be adsorbed deep inside easily. Further, although column 5, lines 1 to 15 of US 4,364,803 states that the operations are repeated, it merely states that the repetition gives the desired metal thickness and it does not state that the metal deposition is obtained inside of the membrane. Moreover, the stated portion of US 4,364,803 fails to disclose the specific order of repetition of the steps. Even if US 4,364,803 implies that the operation of making a metal salt adsorb

membrane and the operation of immersing the membrane in a solution of a reducing agent are repeated alternately, it does not include a rinsing process in the repeated steps.

Therefore, the production method of the present invention is different than either WO 97/26039 or US 4,364,803, whether considered alone or in combination. WO 97/26039 and US 4,364,803, in combination, involve at most a production method of coating a membrane with a solution containing a metal complex and a reducing agent after the pre-treatment of a membrane with an amphoteric material, followed by exposing a membrane to a reducing agent. This method is different from the method of the present invention and it does not state that metal deposition is obtained inside of the resin product. Therefore, even when WO 97/26039 and US 4,364,803 are combined, such a combination does not render the present invention obvious to the skilled person in the art based on such a combination.

Moreover, in the Office Action, the Examiner recites case law, contending that it is well settled that if the steps of a process are the same, the results must be the same unless the difference is due to factors not recited in the claims. However, this contention presupposes that the steps of the process are the same for the prior art as in the application. This is not so in the present case. As discussed above, the prior art references do not conduct the same steps in the same manner as in the present invention. Instead, the specific adsorption, reduction and washing steps are separately conducted and repeated in the specific order claimed in the present invention, which achieves the metal growth within the complex, as discussed above. Only certain of these steps are repeated in the prior art, and the prior art fails in any way to recognize that metal growth can be achieved within the complex by repeatedly conducting the steps in the specified order. Accordingly, the Examiner's contention that the results are the same based on the process steps being the same is not tenable, since the processing steps are in fact different.

Furthermore, new claims 20-23 recite that the counter ions are exchanged with alkylammonium ions. The prior art fails to teach or disclose such a step involving exchange with alkylammonium ions.

In summary, the present invention involves a process for preparing a product by adsorbing a metal complex within an ion-exchange resin product, then immersing the ion-exchange resin product in a reducing agent, then washing the ion-exchange resin product, followed by sequentially repeating these steps. Such process and sequential repeating achieves metal growth within the ion-exchange resin product, not merely on the surface. On the other hand, the prior art relied upon by the Examiner fails to teach or suggest such a step of adsorbing a metal complex followed by a separate step of immersing the product in a reducing agent followed by a washing step, then repeating each of these steps sequentially. It is only through such separate steps and the sequential repetition of these steps that the ion-exchange resin product of the present invention is achieved, which includes metal deposited not only on the surface but also within the inside of the product.

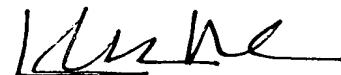
#### CONCLUSION

Based on the foregoing amendments and remarks, the present invention is deemed patentable over the prior art. As such, withdrawal of the rejections, reconsideration and allowance of all of the pending claims are respectfully requested.

Respectfully submitted,

WEBB ZIESENHEIM LOGSDON  
ORKIN & HANSON, P.C.

By



Kirk M. Miles  
Registration No. 37,891  
Attorney for Applicants  
700 Koppers Building  
436 Seventh Avenue  
Pittsburgh, Pennsylvania 15219-1818  
Telephone: 412-471-8815  
Facsimile: 412-471-4094